Patent Application
Attorney Docket No. D/A3036
Express Mail Label No. EU094384182US

COMPRESSION PRINTING

BACKGROUND

1. Technical Field

The present invention in embodiments relates generally to data compression and decompression and, more particularly, to devices and method for the compression of printing hints by processing saturated pixels with different rendering hint values in a very similar manner; for example, similar enough to be indistinguishable by the eye.

2. References

Digital color imaging on high-resolution printers such as xerographic printers requires the handling of large amounts of video data for each page. The color image for each page is typically represented as a set of four color planes, usually cyan, magenta, yellow, and black. Each color plane is a set of scanlines and each scanline is a sequence of individual image pixels.

The image quality can be improved using object optimized printing as described by Motamed in U. S. Patent No. 5,687,303. With object optimized printing, printing hints in the form of metabits are generated for each image pixel and sent to an IOT (Image Output Terminal). The printing hints, which are utilized by a CRM (Contone Rendering Module) within the printer, can optimize such processing subsystems as halftone generation, halftone screen size and angle, color space transformation, tone reproduction curve, IOT output correction, and the like.

The printing hints may improve the quality of the printed output; however, they also may increase that amount of data required to represent the color images. It is

often desirable to reduce the size of the color images and printing hints to reduce the amount of solid state memory required to buffer the images, reduce the amount of disk space to store the images, and speed up transfer of the images within the printing system. This may be accomplished by compressing the page images and printing hints after they are generated and decompressing them immediately before they are needed for printing.

There are a number of different compression schemes to reduce the size of the page images. One such method is to use the lossy or lossless JPEG compression standard. Better compression can be achieved with more complex algorithms. The printing hints should be compressed using a lossless algorithm such as run length coding or a lossless adaptive dictionary-based coding such as described by Eastman in U. S. Patent No. 4,464,650.

The compressed size of the printing hints is dependent on the lossless compression algorithm used and the complexity of the printing hints. The compressed size of the printing hints can be reduced by reducing the complexity of the printing hints.

SUMMARY

There is disclosed in embodiments methods relating to the compression of printing hints. The method in embodiments generates a first set of image pixels having corresponding printing hints. The printing hints are then adjusted to produce a second set of image pixels processed in such a way that an end printed result is visually equivalent to a printed result using the first set of image pixels thereby reducing the entropy in the printing hints. The method improves the compression ratio of an image using printing hints by adjusting the printing hints of pixels that are zero or fully

saturated. The printing hints are adjusted in such a way to reduce the complexity of the printing hints.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an example of a scanline with printing hints being compressed.

DETAILED DESCRIPTION

Aspects disclosed herein in embodiments include generating a first set of image pixels having corresponding printing hints, and adjusting the printing hints to produce a second set of image pixels processed to result in an end print visually substantially equivalent to a printed result using the first set of image pixels. A contone rendering module within a printer generates the first set of image pixels having corresponding printing hints for processing saturated pixels thereby producing different printing hint values. An image output terminal receives the different printing hint values from the contone rendering module to produce a second set of image pixels processed to result in and end print which is visually substantially equivalent to a printed result using the first set of image pixels thereby reducing the entropy in the printing hints.

In embodiments the methods disclosed use of several characteristics of the contone rendering module (hereinafter CRM) in a printer to reduce the complexity of the printing hints. Printing hints may also be referred to as rendering hints or tags. The CRM uses the printing hints along with the corresponding image pixel value to determine the output signal to be sent to an image output terminal (hereinafter IOT). The output of the CRM is dependent on many parameters including the halftone algorithm, screen angle, and pixel location. One characteristic of the CRM is that it almost always generates a full output signal to the IOT for pixels that are fully saturated regardless the value of the printing hint for that pixel. In other words, the CRM handles a saturated pixel very nearly the same when the printing hint indicates it is a text pixel and when the printing hint indicates it is an edge pixel.

The printing hint for a saturated pixel from text pixel to edge pixel can be changed substantially with no significant change in the output image. Changing the printing hint from text pixel to edge pixel may reduce the complexity of the printing hints and thus enable higher compression of the printing hints.

Another characteristic of the CRM is that it usually generates no output signal to the IOT for pixels that are zero regardless the value of the printing hint for that pixel. That is, the CRM handles a zero pixel very nearly the same when the printing hint indicates it is a background pixel and when the printing hint indicates it is an edge pixel. Therefore, the printing hint for a zero pixel from background pixel to edge pixel can be changed etc, with no significant change in the output image. Changing the printing hint from background pixel to edge pixel may reduce the complexity of the printing hints and thus enable higher compression of the printing hints.

Lossy data compression techniques provide for an inexact representation of the original uncompressed data such that the decoded (or reconstructed) data differs from the original unencoded/uncompressed data. Lossy data compression is also known as irreversible or noisy compression. Entropy is defined as the quantity of information in a given set of data. Thus, one obvious advantage of lossy data compression is that the compression ratios can be larger than the entropy limit, all at the expense of information content. Many lossy data compression techniques seek to exploit various traits within the human senses to eliminate otherwise imperceptible data. For example, lossy data compression of visual imagery might seek to delete information content in excess of the display resolution or contrast ratio.

Also, lossless data compression techniques can provide an exact representation of the original uncompressed data. Simply stated, the decoded (or reconstructed) data is identical to the original unencoded/uncompressed data. Lossless data compression is also known as reversible or noiseless compression. Thus, lossless data compression has, as its current limit, a minimum representation defined by the entropy of a given data set.

Referring now to **FIG. 1**, there is illustrated examples of a scanline with printing hints being compressed. As shown in **FIG. 1**, a scanline **10** of print data

consists of a sequence of pixels. Pixels **12** with a value of zero indicate areas where there should be no toner while pixels **16** with a value of 255 indicate areas of maximum toner. Pixels **14** with an intermediate value indicate areas where toner, comprised for example of a suitable resin and colorant will be present or not present based on the halftoning algorithm. In this particular scanline the pixels **14** are edges between an area of white pixels **12** and an area of fully saturated pixels **16**, perhaps part of a text character rendered with anti-aliasing technology.

The scanline **10** can be compressed into a scanline **18** using a run length compression scheme. The compressed scanline **18** consists of pairs of values **20** and **22,** respectively. The first value **20** of the pair is a run length. The second value **22** of the pair is the value of the pixels in the run. In this particular case the use of run length coding does not reduce the size of the encoded scanline compared to the original.

Referring once again to **FIG. 1**, associated with scanline **10** is a scanline **24** of printing hints. There is a one-to-one correlation between the pixels and the printing hints. Printing hints **26** with a value of zero indicate background (white) pixels. Printing hints **30** with a value of one indicate fully saturated pixels. Printing hints **28** with a value of two indicate edge pixels.

The scanline **24** of printing hints can be run length compressed into a scanline **32** of compressed Printing hints. In this example the use of run length coding does not reduce the size of the encoded scanline of printing hints compared to the original.

In embodiments the methods disclosed optimizing the printing hints so that they will compress better using run length compression. This optimization takes advantage of a characteristic of the rendering algorithm in the CRM. A fully saturated pixel with a printing hint indicating it is a text pixel is processed in the CRM in very

nearly the same way as a fully saturated pixel with a printing hint indicating it is an edge pixel. Taking advantage of this characteristic, all of the printing hints indicating saturated text pixels can be replaced with printing hints indicating edge pixels. Turning once again to **FIG. 1**, the scanline **34** of improved printing hints contains only background hints **26** and edge hints **28**.

The scanline **34** of the printing hints can be run length compressed into a scanline **36** of compressed improved Printing hints. In this example the use of printing hints increases the amount of compression. Relative to the data size required in scanline **32**, the compressed data size using this method is reduced by 40%.

It is possible to further optimize the printing hints so that they will compress even better using run length compression. This further optimization takes advantage of another characteristic of the rendering algorithm in the CRM. A zero pixel with a printing hint indicating it is a background pixel is processed in the CRM in very nearly the same way as a zero pixel with a printing hint indicating it is an edge pixel. Taking advantage of this characteristic, all of the printing hints indicating background pixels can be replaced with printing hints indicating edge pixels. Once again, referring to **FIG. 1**, the scanline **38** of optimized printing hints contains only hints edge hints **28**.

The scanline **38** of optimized printing hints can be run length compressed into a scanline **40** of compressed optimized printing hints. In this example the use of optimized printing hints increases the amount of compression significantly.

In this process, the first step is to generate the image pixels and the corresponding printing hints. The next step is to adjust the printing hints for image pixels that are fully saturated. Fully saturated pixels that are adjacent to pixels with printing hints indicating they are edge pixels will have their printing hints changed to indicate that they are edge pixels. The next step is to adjust the printing hints for

image pixels that are zero. Zero pixels that are adjacent to pixels with printing hints indicating they are edge pixels will have their printing hints changed to indicate that they are edge pixels. The final step is to losslessly compress the optimized printing hints. In this case, relative to the data size required in **32**, the compressed data size using this method is reduced by 80%.

This example uses run length compression to demonstrate the improved compression from the simplification of the printing hints. Other compression algorithms could be used.

The claims, as originally presented and as they may be amended, encompass variations, alternatives, modifications, improvements, equivalents, and substantial equivalents of the embodiments and teachings disclosed herein, including those that are presently unforeseen or unappreciated, and that, for example, may arise from applicants/patentees and others.